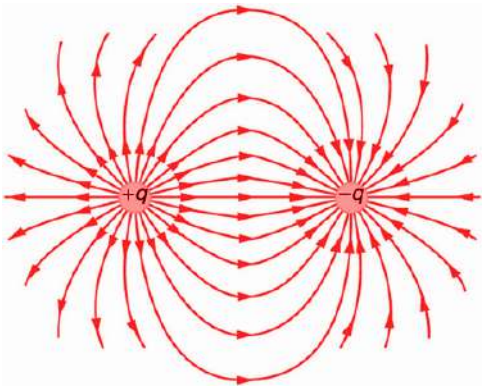
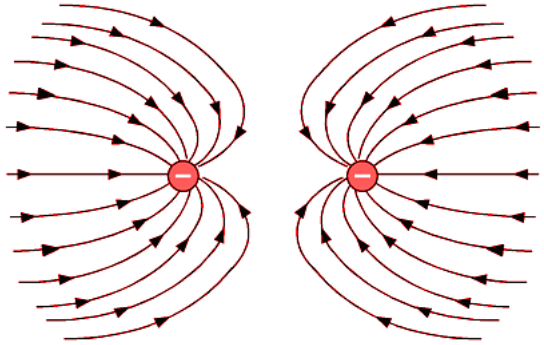
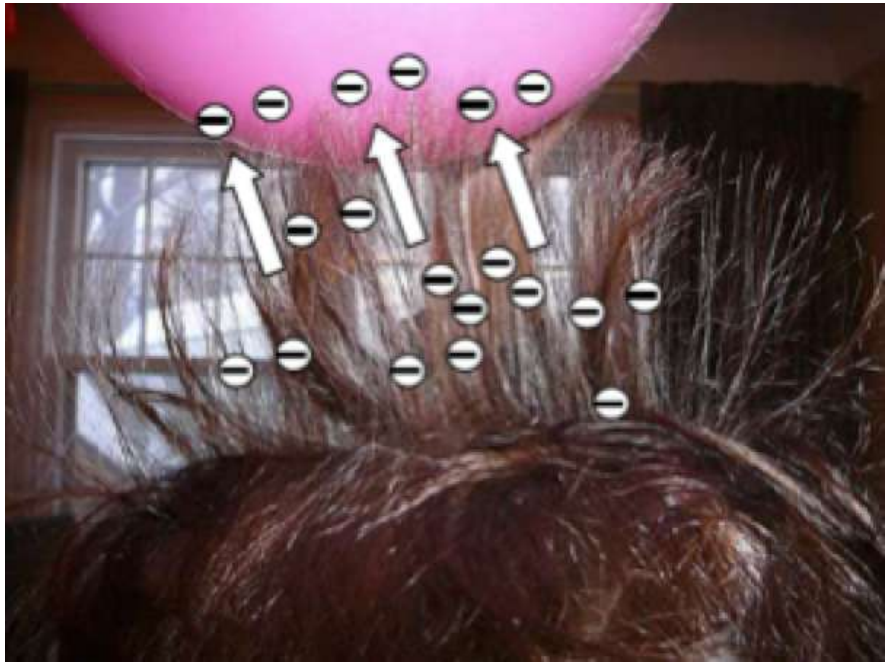
Electric Charges, Forces, and Fields





Rubbing a balloon in hair (Friction?)



Triboelectric series

- Ranks materials according to their tendency to give up their electrons.

THE TRIBOELECTRIC SERIES

Positive
Rabbit's fur
Glass
Wool
Cat's fur
Silk
Felt
Cotton
Wood
Cork
Rubber
Celluloid
Negative

Phet simulation

https://phet.colorado.edu/en/simulation/balloons-and-static-electricity

Tape demonstration

http://www.phys.hawaii.edu/ams02/outreach/em_scotch.php

Whiteboard: Draw what you think might be happening to the scotch tape in each scenario. Work with elbow buddy.

Tape demonstration #1

Place both pieces of tape onto the desk and ensure good contact.

Pull up quickly.

Bring the tape near each other, but not touching. Observe.

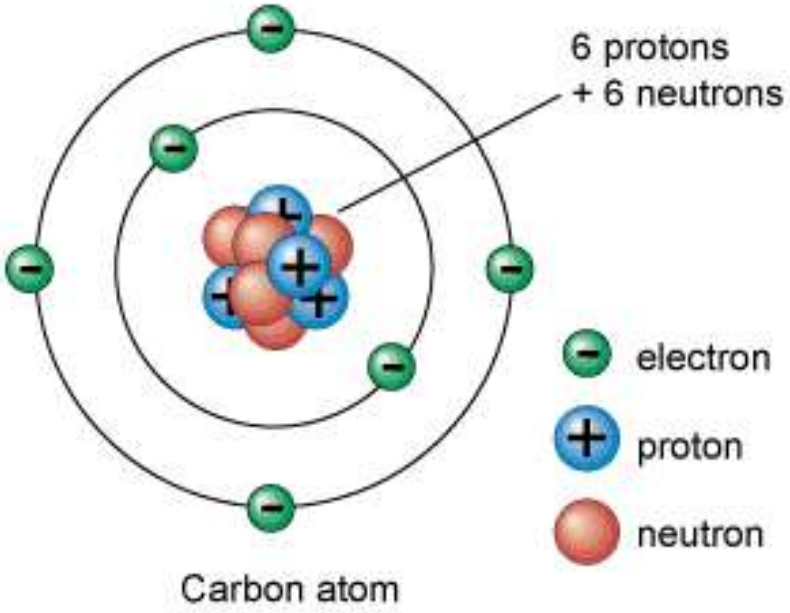
Tape demonstration #2

Place one piece of tape on the desk and label it B for bottom. Then, place the second piece of tape on the desk and label it T for Top.

Pull both pieces up off the desk together. Then, pull the two pieces apart from each other.

Bring the pieces of tape near each other and observe.

Set up of the atom



Only the electron is free to move about and jump from object to object.

Elementary Charge, e

All electrons have exactly the same charge. Protons also have a charge of the same magnitude, but with an opposite sign.

Magnitude of an Electron's Charge, *e*

$e = 1.60 \times 10^{-19}\ \text{C}$

SI unit: coulomb, C

$$Q = ne$$

Q = Total charge
n = Number of electrons or protons
e = Charge of 1 electron or proton

Example

1. Find the net charge of a system consisting of 4.1×10^{-7} electrons.

2. If a piece of tape has a charge of 1.328×10^{-17} C, how many electrons are on the piece of tape?

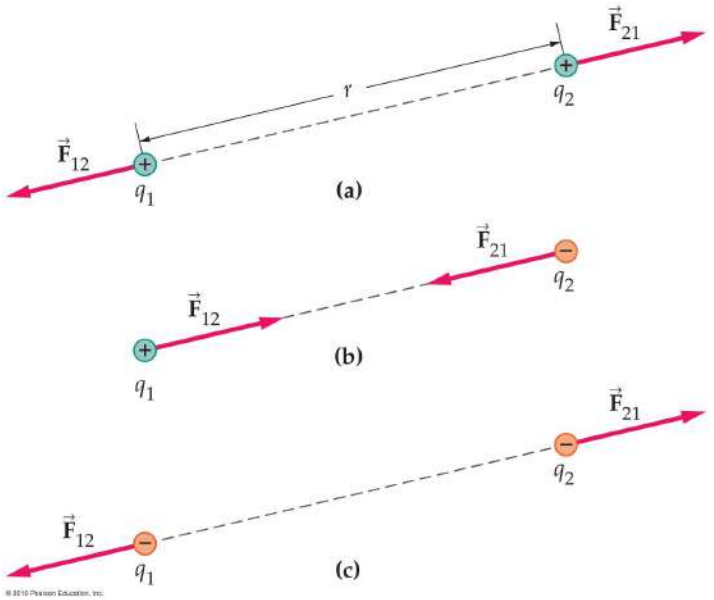
Electric Force

Coulomb's Law gives the force between two charged objects:

$$F = k\frac{|q_1||q_2|}{r^2}$$

SI unit: newton, N

$$k = 8.99 \times 10^9\ \mathrm{N \cdot m^2/C^2}$$



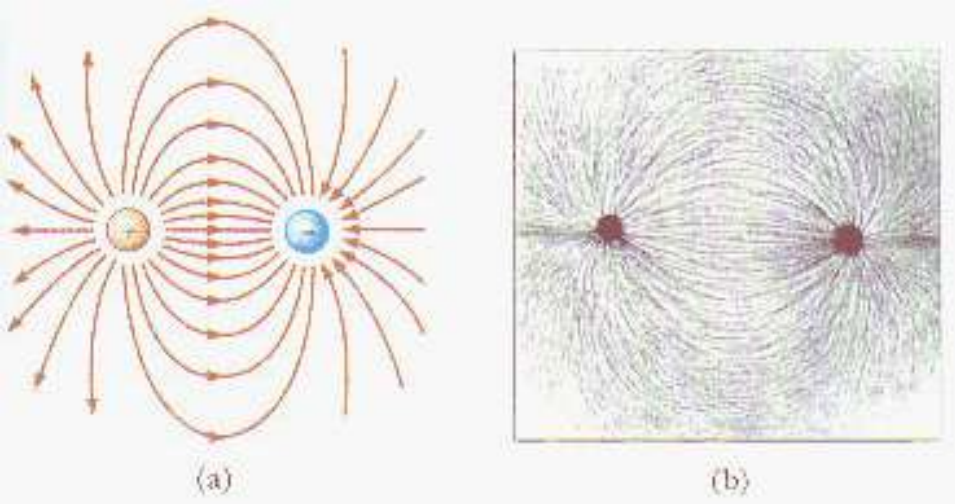
Example

A charge q1= -5.4×10^{-6} Coulombs is at the origin, and a charge q2 = -2.2×10^{-6} Coulombs is on the x-axis at x=1 meter.

1. Find the electric force between the two charges.

1. Is the force attractive or repulsive?

Electric Fields

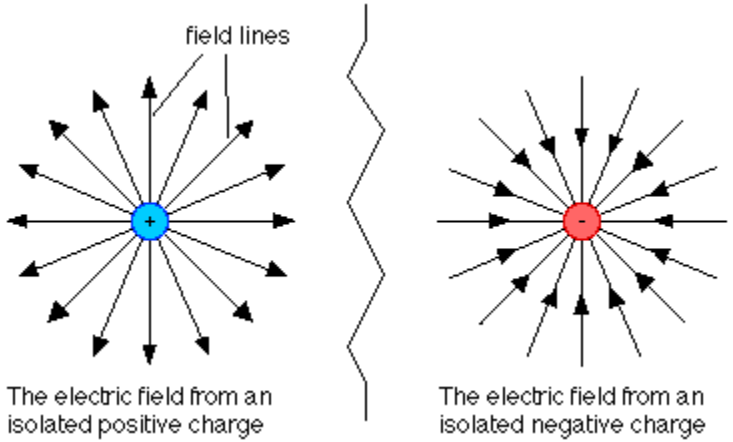


Does the electric field even exist?

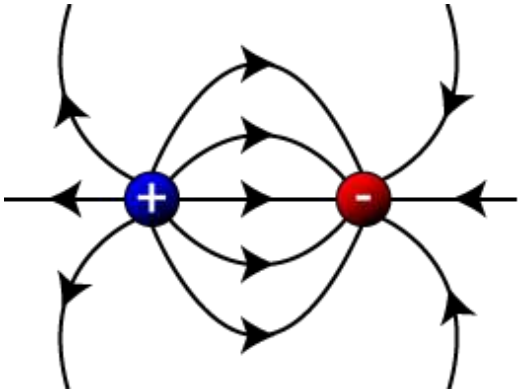
Can we see an electric field?
How can a force be exerted over empty space?

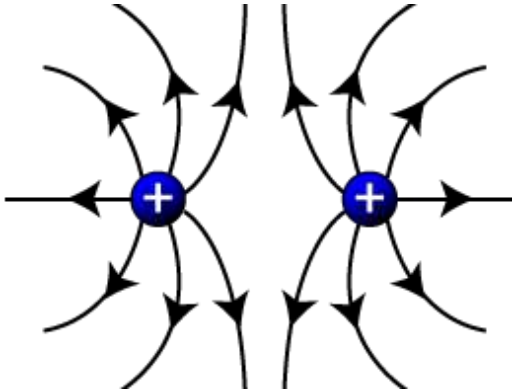
Electric field

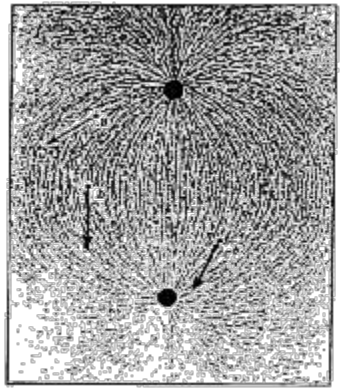
Any charged particle will create an electric field. Another charged particle placed in the electric field will feel a force.



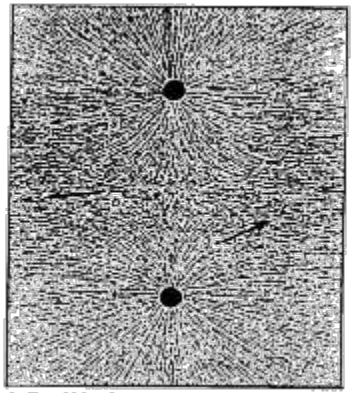
Putting particles together





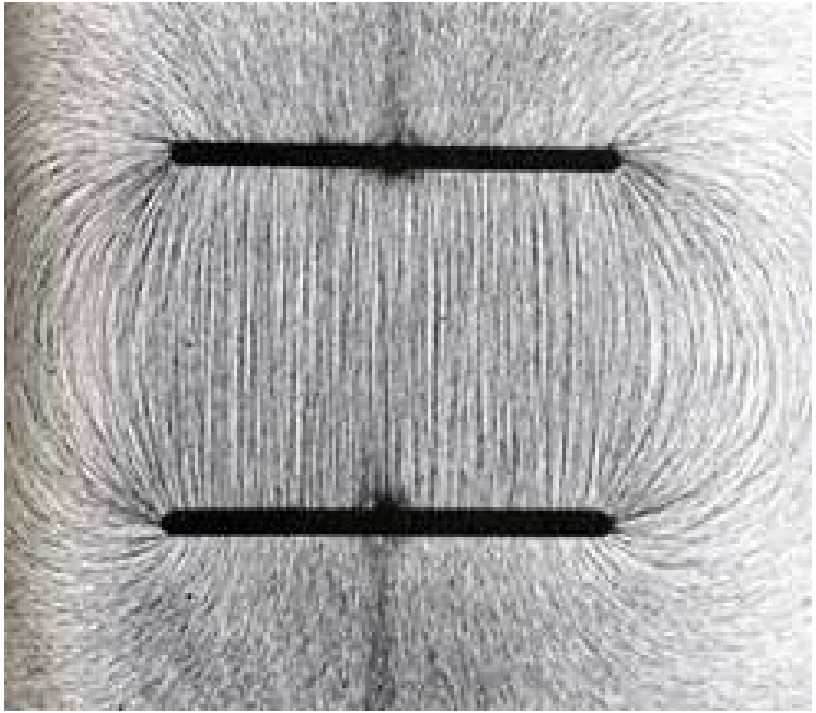


a. Equal and opposite charges

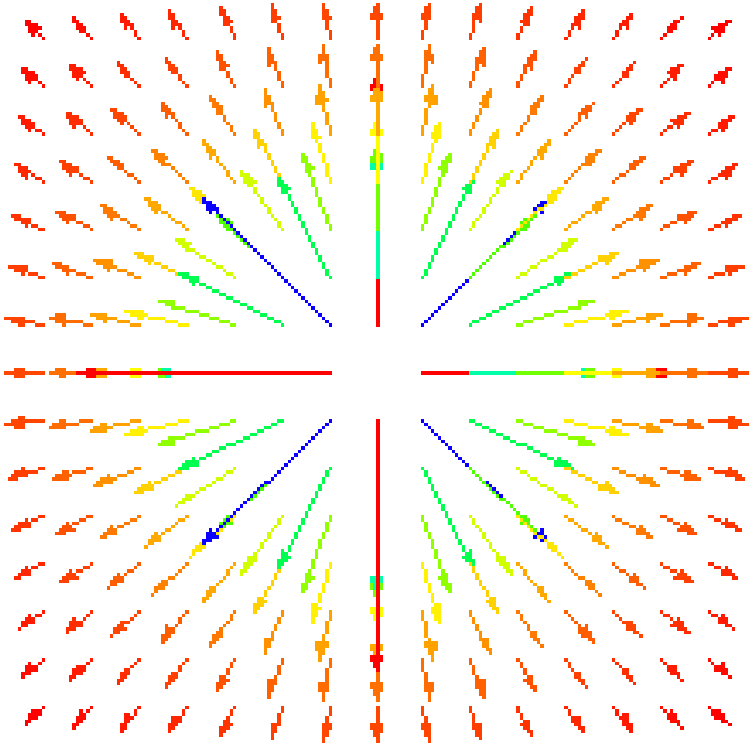


b. Equal like charges

Two charged plates



Electric field strength



Electric field strength equation

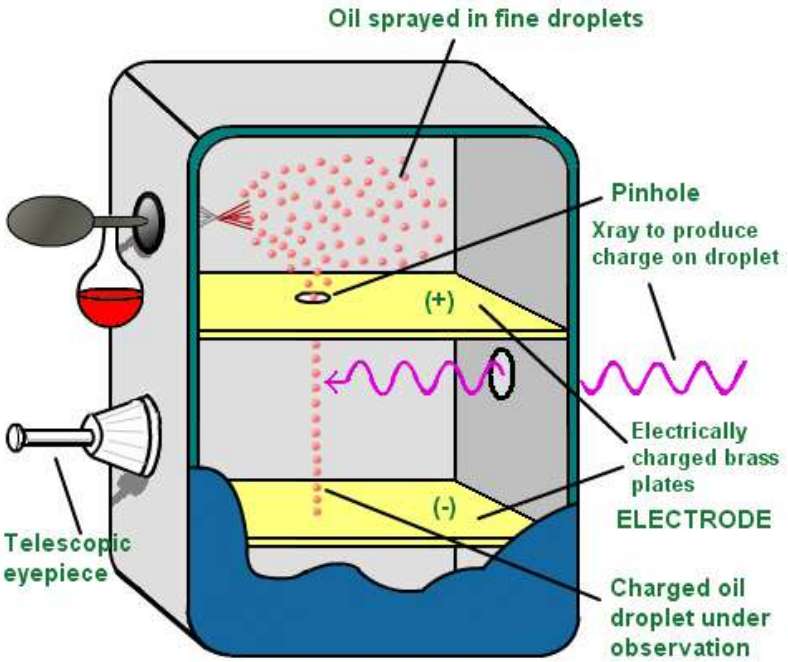
$$F = qE$$

F = force (N)
q = charge (C)
E = electric field (N/C)

Example problem

A positive charge of magnitude 2.4E-8 C experiences a force of 1.5E-3 N. What is the strength of the electric field at that position?

Millikan's Oil Drop Experiment



Freebody Diagram of Experiment

Practice Problem

A balloon with a charge of q = 4.8E-7 C is suspended in an electric field with a strength of 400 N/C. What is the mass of the balloon?